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Plasticulture

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In the contemporary era, the global population is experiencing a remarkable increase. Therefore, addressing the escalating need for food production has become imperative to combat the prevailing hunger challenges worldwide. The introduction of "Green Revolution" stands as a transformative blessing for our nation, steering us from an era of food grain deficiency to achieving self-sufficiency (Mohanty and Patro, 2020). In the initial stages, our country faced challenges in meeting the demand for food grains, but the advent of the Green Revolution marked a pivotal turning point. Hence, in order to usher in a more promising era of agriculture, it is imperative to embrace innovative and sustainable farming practices that can contribute to the transformation of the agricultural landscape in the near future. Out of the many hi-tech horticulture practices, Plasticulture represents a highly beneficial input in agriculture that has the potential to reshape the landscape of Indian farming in the emerging era. Plasticulture represents a scientific approach to conducting both agriculture and horticulture. It goes beyond merely enhancing productivity, also focusing on optimizing input resources. In doing so, plasticulture effectively minimizes costs associated with agricultural practices. Plasticulture provides a myriad of benefits that include moisture conservation, decreased reliance on fertilizers, precise administration of water and nutrients etc.

Importance of Plastic

Many years ago, predating the advent of plastic, farmers relied solely on traditional knowledge. The adoption of plastic, as opposed to traditional practices, offers various benefits such as preventing soil erosion, conserving water, controlling unwanted weed growth, regulating the presence of pathogens and insects, extending shelf life, and enhancing overall yield. Agriculture extensively employs plastic materials, including polyethylene (PE), polypropylene (PP), ethylene-vinyl acetate copolymer (EVA), polyvinyl chloride (PVC), polycarbonate (PC), poly methyl 1-methacrylate (PMMA), and glass fiber reinforced polyester (Plastic Europe, Picuno, 2018). The utilization of bio based plastic nets, specifically polymers such as poly amino acids, polysaccharide derivatives, polyhydroxybutyrate,

polycaprolactone, polyhydroxylalkanoate, and polylactic acids, represents a more advanced and environmentally safer approach due to their inherent biodegradability (Maraveas, 2020).

Advantages

- Earlier planting and faster growth: Dark and clear mulches intercept sunlight, lowering soil temperature and promoting early and rapid plant growth.
- Soil moisture retention: Plastic mulches minimize water loss through evaporation, reducing irrigation needs and ensuring even moisture distribution to alleviate plant stress.
- Weed management: Plastic mulch inhibits weed growth by blocking sunlight from reaching the soil and impeding the weed's growth pathway.
- Optimizing fertilizer use: Drip irrigation with plastic mulch minimizes fertilizer leaching below the root zone, ensuring precise application of nitrogen and nutrients only where needed. This results in a significant reduction in fertilizer requirements compared to broadcast fertilization with flood and furrow irrigation.
- Crop quality: Plastic mulches decrease the contact of fruits and vegetables with soil, minimizing fruit rot and other diseases.
- Better soil aeration: Plastic mulch diminishes the crusting impact of rain and sunlight, reduces weed quantity, enhances soil aeration, and supports microbial activity.
- Root damage reduction: Reducing weed presence eliminates the necessity for cultivation, thereby minimizing root damage and enhancing overall plant growth.

Disadvantages

- Cost: Plastic mulching encompasses equipment, plastic film, transplanters for plastic beds, and extra labor for both installation and removal of the films that incurs a significantly higher cost than planting on bare soil.
- Environmental concern: Traditional plastic mulch films, when used, tend to accumulate in the soil, posing economic and technical challenges for disposal. Biodegradable plastics offer a viable alternative as they naturally degrade through microbial processes over time.

Applications

1. **Propagation and Nursery Management:** Plastics are typically utilized in propagation for grafting and layering. Polythene strips are used in grafting to connect the scion and stock together. Poly-wrappers in various colors are used for layering. Because red, blue, and black poly-wrappers increase physiological activities (etiolating effect), which is necessary for cell division and enlargement, they have a greater success rate for rooting and survival. Plastics are of immense importance in agriculture right from the nursery planting stage as they are use in nursery bags, pro-trays, hanging baskets, trays plastic plugs, coco-pits, etc for planting the young seedlings and seeds. Moreover, in order to maintain an insect proof in the nursery the use of nylons nets have been commercialized to develop a healthy, virus free environment in the nursery during the rainy season. In the height of summer, when temperatures range from 40 to 45 degrees Celsius, a 40–45% shade net covering can be used to develop an excellent nursery for early cauliflower, cabbage, etc (Kaur and Singh, 2022). On the other hand, during the hard winters, a variety of vegetables, including cucumber, tomato, capsicum, brinjal, and cucurbitaceous crops, can be raised in a nursery by covering the insect-proof net house with 200 micron thickness plastic sheet. With a few small changes, we can raise virus-free, healthy nurseries year-round in one facility.
2. **Drip Irrigation:** Water savings can reach 60–70% with drip irrigation, meaning that a well, canal, etc. can nearly triple the amount of cropland that can be planted. With this technique, emitters allow water to drip or trickle through plastic placed adjacent to the base of the plants at a predetermined rate. The main benefit of using plastic in a drip

irrigation system is that the components are resistant to rust, making them suitable for inline irrigation, or subsurface irrigation.

3. **Naturally Ventilated Polyhouse Technology:** These are structures having 40 mesh, insect proof nylon nets covering the polyhouse from all four sides giving shield to the crops from harsh climatic conditions, insect and diseases. A nylon net composed of insect-proof material can be used in place of roof ventilators to provide natural air flow and ventilation free from insects. This kind of polyhouse doesn't require electricity. High-value crops like tomatoes, capsicums, parthenocarpic cucumbers, etc., and flowers like roses, chrysanthemums, and gerberas may be cultivated with ease in peri-urban locations, which is where this kind of construction is appropriate.
4. **Mulching:** It is the process of covering soil with organic agricultural wastes or plastic films surrounding plants in order to prevent weed development, limit evaporation of moisture, and insulate the soil from the environment's chilly night-time temperatures. Thus, it aids in shielding plant roots from extremes of temperature and moisture, and heavy rainfall also lessens soil erosion.

- **White Film Mulching:** It lowers the soil temperature by lowering the quantity of radiation transmitted.
- **Black Film Mulching:** This material functions as an infrared radiator and a black body absorber, blocking out UV, visible, and infrared radiation. It is opaque to incoming solar energy.
- **Infrared Transmitting Film Mulch:** This type of mulch selectively transmits a portion of the electromagnetic spectrum and was newly discovered in polymeric mulch technology.
- **Coloured Film Mulches:** By reflecting photosynthetic active wavelengths, red mulch yields the greatest results for tomatoes, while blue mulch yields the best results for peppers. Whitefly control is said to be achieved by silver mulch, whereas yellow-brown plastic mulch is said to postpone the occurrence of yellow leaf curl.

Table 1: Increase in yield of vegetable crops through plastic mulching

Crop	Yield (t/ha)		Increase in yield (t/ha)
	Unmulched	Mulched	
Cabbage	14.30	19.90	39.16
Cauliflower	18.58	25.02	34.66
Tomato	69.10	94.85	37.26
Chilli	16.79	19.71	17.39
Okra	6.91	8.56	23.88
Bitter Gourd	20.12	25.63	27.39
Brinjal	36.73	47.06	28.12
Broccoli	15.64	25.14	60.74
Source: Bhattacharya *et al*., 2018			

Future Thrust

Plasticulture offers a substantial reduction in the carbon footprint of various products, contingent upon its applications. The integration of bioplastics holds the promise of significantly diminishing our reliance on environmentally detrimental fossil resources. Anticipating a notable increase in the production and utilization of bioplastics in the foreseeable future, there is a pressing demand for continued research and development in the realm of biodegradable polymers. This imperative stems from our responsibility as stewards of the environment, making advancements in biopolymers a driving force for unlocking their tremendous potential in the years ahead.

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